U.S. ELV CRADA

Sustainable End-of-Life Vehicle Recycling

R&D Collaboration between
Industry and the U.S. DOE

Optimizing Recyclability

Removing Barriers

Harnessing Market Forces

Dear Automotive Recycling Colleagues:

Advances in vehicle recyclability over the next 20 years will enhance the sustainability and profitability of automotive recycling—which is already an essential earth friendly industry.

Today, the automobile recycling community plays a crucial role in the efficient, ecological management of obsolete vehicles, also known as end-of-life vehicles (ELV). Automotive recyclers have developed an efficient infrastructure that processes ELVs to recover parts and materials for repair, reuse, and remanufacture. For more than 75 years, automotive recyclers have been providing local employment, consumer service, and environmental conservation worldwide.

Automotive recycling has evolved into a sophisticated market serving a technology-driven industry. Further advances are on the horizon as research removes technical and economic barriers to ELV recycling. Through collaborative partnerships, we plan to help dramatically increase ELV recycling for the benefit of society and our environment.

In 2003, we developed a five-year, multi-million dollar, cost-shared Cooperative Research and Development Agreement (CRADA) to significantly expand and enhance the sustainable recycling of automotive materials. The U.S. ELV CRADA Team is working diligently with government, academic, and industry leaders to develop the necessary technologies to improve recyclability nationwide by 2020. We seek to enable optimal recycling of all automotive materials by fostering market-driven recycling and by removing barriers to the recycling of advanced, lightweight materials.

This brochure highlights the broad range of R&D activities now underway by members of the U.S. ELV CRADA Team. We believe these activities can advance technology for the sustainable recycling of materials used in vehicles today and in the future.

Sincerely,

Joe Carpenter
U.S. Department of Energy

Mike Fisher
American Plastics Council

Claudia Duranceau
Ford Motor Company

Ed Daniels
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Candace Wheeler
General Motors Corporation

Gerald Winslow
Daimler Chrysler Corporation

Long-Term Partnership Goals

The next 20 years will see major advances in the sustainable recovery of automotive materials. The automotive recycling community has created long-term partnerships focused on the following three goals:

- Enabling optimum recycling of all automotive materials
- Removing recycling barriers to the use of advanced, lightweight materials
- Fostering market-driven vehicle recycling

> **By 2020, everyone will share in the broad economic and environmental benefits of market-driven automotive recycling.**

Benefits of End-of-Life Vehicle (ELV) Recycling Today

- Conserves Land — Over 75% of the materials from 15 million ELVs are recovered and recycled in the United States annually.
- Saves Energy — The United States recycles over 14 million tons of steel, saving 170 trillion Btu of energy each year.
- Preserves Natural Resources — The U.S. Steel Recycling Institute estimates that recycling one ton of steel conserves 2,500 pounds of iron ore, 1,400 pounds of coal and 120 pounds of limestone.
- Lowers Emissions — The U.S. Environmental Protection Agency estimates that steel mills which substitute low-sulfur scrap metal for high-sulfur raw ore can reduce their air pollution potential up to 86 percent and water pollution potential by up to 76 percent.
- Reduces Costs — Wholesale and retail customers can save money when purchasing recycled parts and components over comparable new parts.
- Creates Jobs — Over 46,000 people work at more than 6,000 businesses in the United States.

Improving on Success

Automotive materials recycling is a success story. Yet, up to 25% of the materials are not presently recovered and recycled. These unrecovered materials are commonly referred to as "shredder residue" and are generally land filled. As automotive designs evolve to further improve safety and performance, they will incorporate an increased share of innovative, lightweight materials. This trend could mean more waste for landfills as newer vehicles age—unless new technologies are developed to recover the new materials.

A Government/Industry Collaboration

Industry and government have come together to address challenges to the sustainable recycling of current and future automotive materials. The U.S. Department of Energy (DOE) has structured a five-year, multi-million dollar, cost-shared Cooperative Research and Development Agreement (CRADA) among three leaders in science and technology:

- Argonne National Laboratory
- The Vehicle Recycling Partnership of the United States Council for Automotive Research (USCAR)—a partnership of DaimlerChrysler Corporation, Ford Motor Company, and General Motors Corporation
- The American Plastics Council (APC)

The U.S. ELV CRADA Team is actively engaged in a broad range of R&D activities to advance technology for the sustainable recycling of materials used in automotive vehicles today and in the future.

AUTO RECYCLING CRADA — Richard T. Gutowski of DaimlerChrysler Co. pours auto-shredder residue that has been cleaned and sorted for recycling. Watching are (left to right) Ed Wall of the U.S. Department of Energy, Harvey Drucker of Argonne National Laboratory, and James Kolb of the American Plastics Council.

The Team's R&D agenda focuses on the following key objectives:

- Develop and demonstrate sustainable technologies and processes for ELV recycling
- Demonstrate feasibility of resource recovery from shredder residue, including materials recovery for re-use in automotive and other applications, chemical conversion of residues to fuels and chemicals, and energy recovery
- Develop viable strategies for the control and minimization, or elimination, of substances of concern
- Benchmark recycling technology and provide data to stakeholders
- Stimulate markets for reprocessed materials to support economic collection, processing, and transportation
- Transfer technology to commercial practice

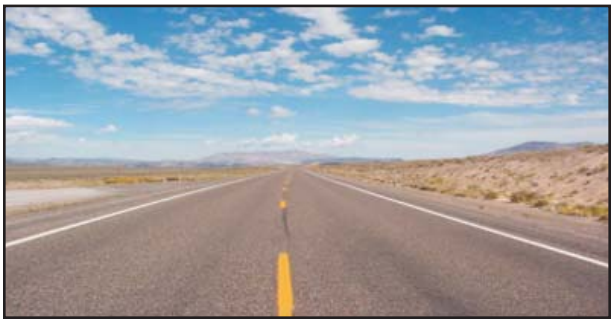
Together Argonne, VRP, and APC are pursuing an aggressive research program to develop and demonstrate technologies to recover and recycle automotive materials within the existing recycling infrastructure.

This powerful collaboration creates a core of expertise and resources to help significantly expand and enhance the sustainable recycling of automotive materials.

Road Mapping the Future

Recycling Assessments and Planning

In September 2000, the DOE Office of Advanced Automotive Technologies and the Argonne National Laboratory co-sponsored a workshop on the R&D needed to recycle the automotive materials and components that will reach end-of-life status in 2020. This event brought together 24 experts representing original equipment manufacturers (OEMs), material suppliers, recyclers, and researchers. Participants reached consensus on the goals, challenges, and top critical needs for improving automobile recyclability. The output from the workshop was analyzed and incorporated into the document, *A Roadmap for Recycling End-of-Life Vehicles of the Future*. This document is available on the Argonne National Laboratory website at http://pe.es.anl.gov (see Documentation link).



The roadmap established priorities and developed a 5-year research plan that includes:

- An analysis of the baseline technology and infrastructure
- Development and demonstration of materials recovery technologies
- Evaluation of recovered materials performance and market potential

Creating Industry Benchmarks

Baseline Assessment of Recycling Systems and Technology

A better understanding of the interrelationships among all phases of sustainable automotive recycling will help to clarify the environmental and economic tradeoffs of material design, recycling technologies, and process operation. Determining the status of technologies used, existing process capabilities, and the mass balance flow of automobiles at end-of-life will help industry to measure the impacts of its efforts. This project can establish the baseline or state-of-the-art for automotive materials recycling systems and technology.

Objectives of this project include the following:

- Review, profile, and develop a database of state-of-the-art automotive materials recovery/recycling technologies
- Review international, federal and state regulatory information regarding vehicle recyclability, substances of concern, and recycle laws and mandates
- Conduct life-cycle studies to quantify the environmental burdens and benefits associated with various end-of-life recycling technologies
- Conduct reference case end-of-life recyclability studies

Baseline technology assessments will facilitate effective allocation of R&D resources to advance sustainable vehicle recycling for the future.

Building Business Models

Post-Shred Materials Recovery Technology Development and Demonstration

New materials recovery technologies are currently at various stages of development and demonstration. Data on these technologies can help to build a business case for recycling of materials from automotive post shredder residue.

Objectives of this project include the following:

- Characterize shredder residues from a number of sources to determine composition variability
- Conduct bench-scale and large-scale tests to benchmark emerging technologies and processes for material recovery
- Build and operate a shredder residue separation pilot-plant to produce samples of recovered materials for market evaluation
- Conduct cost and performance analysis of alternative technologies to establish the business case for selected technologies and identify technology gaps
- Develop a process cost model for the recovery of automotive plastics
- Evaluate technology developments with representatives of the automotive shredding industry

> **Technologies specific to the recovery of materials from post-shredding streams are demonstrated and evaluated to better understand the commercial viability of those processes.**

Supporting Data for Material Applications

Compatibilization/Compounding Evaluation of Recovered Polymers

Most recovered automotive materials are 10 to 15 years old. At present, little data is available concerning the physical properties of the polymers that are recovered. This lack of data hinders the identification of applications for those recovered materials. This project will establish properties of polymeric materials recovered from shredder residue, identify limitations on the re-use of those materials, and determine the need for material upgrading technology to meet market requirements.

Objectives of this project include the following:

- Establish a test protocol for material testing, content characterization, and physical properties testing of polymeric materials
- Evaluate the properties of recovered polymers (including polymers recovered in the project described above)
- Establish a database of properties of recovered polymers compared to virgin polymers
- Evaluate the market potential for clean, mixed plastics streams recovered from shredder residue
- Identify candidate automotive and other applications
- Conduct mold trials using recovered polymers

> **Without clear market drivers, creating the market pull needed to significantly improve recyclability will be impossible.**

Removing Contaminants from Recovered Materials

Development of Technology for Removal of PCBs and Other Substances of Concern (SOCs)

The presence of polychlorinated biphenyls (PCBs) and other substances of concern (SOCs) in vehicles can adversely affect the recyclability of automotive materials. Their presence even at parts per million levels can prevent the re-use of materials (such as polymers and polyurethane foams). Technology is needed to effectively remove SOCs from recovered materials in compliance with regulatory requirements and consistent with market requirements for the recovered material.

Objectives of this project include the following:

- Identify efficient and environmentally acceptable process solutions for removing contaminants (including PCBs from materials recovered from shredder residue)
- Test large-scale commercial equipment for cleaning recovered plastics
- Identify necessary modifications to existing equipment to improve their performance and/or economics
- Examine variances in analytical procedures/test results for PCB analysis

Outreach

The U.S. ELV CRADA Team actively seeks opportunities to work in cooperation with other major stakeholders in the United States, Europe, and Asia. Sustainable ELV recycling is a global issue. Cooperative efforts will further leverage available funds, knowledge, and other resources to accelerate technology solutions.

Efforts to Date

- A joint DOE, USCAR, and APC paper on "Market Driven Recycling in North America" was presented as the keynote paper at the recent 2004 International Car Recycle Congress in Washington, D.C. The Team will continue to present papers outlining the industry/government collaboration at international conferences.
- Team representatives have delivered presentations to members of the Institute of Scrap Recycling Industries and are developing a relationship with this organization.
- A U.S. ELV CRADA Team website is under development, including a one-page CRADA summary.

The partnership promotes socially responsible and economically achievable solutions for end-of-life vehicles.

Acknowledgement:

The U.S. ELV CRADA Team is actively engaged in a broad range of R&D activities to advance technology for the sustainable recycling of materials used in automotive vehicles today and in the future.
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And read our roadmap:

A Roadmap for Recycling End-of-Life Vehicles of the Future
(Visit http://pe.es.anl.gov and follow the Documentation link)

Vehicle Recycling Partnership

American Plastics Council